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The PRINCIPLES of

Natural Philosophy

EXPLAIN'D and ILLUSTRATED by

EXPERIMENTS;

In a COURSE of

SIXTEEN LECTURES:

To be perform'd at

Mr. *FULLER's* ACADEMY,

In *Lothbury*, near the *Royal Exchange*.

By J. ROBERTSON, *F. R. S.*

M.DCC.XLV.

COMMISSIONERS OF PATENTS FOR INVENTIONS

BRITISH MUSEUM 30 NOV 71

This COURSE will conſiſt of Five Parts.

I. MECHANICS; wherein will be explain'd the Laws of Motion; the Nature and Uſes of the Mechanical Organs (or Powers.) The Operations of ſeveral Engines; the Quantity of Friction; the Doctrine of Projectiles, of Pendulums, of Central Forces, *&c.*

II. HYDROSTATICS; or the Nature and Properties of Fluids explained: And alſo the Conſtruction of ſome of the Engines which are applied to the Uſes deduc'd from this Science.

III. PNEUMATICS; in which will be ſhewn the Properties of the Air by a great Variety of Experiments.

IV. OPTICS; in this Part, the Nature and Properties of Light, Viſion, Optic Glaſſes and Optical Inſtruments will be fully illuſtrated.

V. ASTRONOMY; where the Motions of the Heavenly Bodies will be explain'd, by the Planetary and other Inſtruments.

The Charge of attending the Lectures of this Courſe will be Two Guineas; to be paid either at the Time of Subſcribing, or on the meeting at the firſt Lecture.

Any Gentleman who ſubſcribes to this Courſe, may attend any future Courſe for one Guinea.

This Courſe will begin on *Monday* the 22 Day of *February* at 6 in the Evening

IN. O. M. E.

Heads of the PRINCIPLES treated of,

AND

EXPERIMENTS,

Which will be made Uſe of in this

COURSE.

MECHANICS.

LECTURE I.

OF Philoſophy, and the Methods of Philoſophizing.

Of Matter, its Extenſion, Diviſibility, and other Attributes.

Of a Vacuum; this proved by Experiment.

Of the Univerſal Law of Gravitation.

Of Attraction by Coheſion, explain'd by various Experiments, ſuch as the Aſcent of Liquors in Glaſs Tubes, between Glaſs Planes, *&c.*

Of Magnetical Attraction and Repulſion, illuſtrated by Experiments.

Of Electrical Attraction and Repulſion, with ſeveral Experiments thereon.

Of Place, Time, and Motion.

Sir *Iſaac Newton*'s Three Laws of Motion explain'd.

LECTURE II.

OF the Effects of Gravity.
Of the Direction and Quantity of Motion in Bodies.
Of the Centers of Gravity, and of Motion.
Experiment to ſhew how the Center of Gravity in any Body may be found, and how to diſtinguiſh it from the Center of Motion.
Experiment ſhewing how a Body may appear to aſcend, during the Time it actually deſcends.
Experiments ſhewing how to ſuſtain a Body, which of itſelf would fall, by adding thereto one or more Bodies.
General Rules for finding the Center of Gravity.
Of the Compoſition of Forces.
Experiments thereon.
Of the Congreſs of Bodies.
Experiments of the ſtriking of non-elaſtic Bodies.
Experiments on Elaſtic Bodies.
How to compute the Momentum of Bodies after their ſtriking each other.
Of Oblique Percuſſion, and how to find the Path which Bodies will take after their Shock.

LECTURE III.

OF Simple Machines and Mechanical Organs.
Of the Ballance, its Uſe and Application.
Of the *Roman*, *Daniſh*, and *Chineſe* Stillyards.
Of the falſe Balance, and how the Deceit may be detected.
Of Levers, and their ſeveral kinds.
Of the Combination of Levers.
Of Pulleys and Rollers, ſingle and combined.

A curious Experiment to ſhew the Loſs of Weight, while Bodies hanging over a Pulley are in Motion.
Of the Wheel and Axle.
Of the Axle and Compound Wheels.
Of the Inclined Plane.
Experiments thereon; and how to find the Loſs of Weight.
Of the Wedge.
Of the Screw.
Of the ſeveral Inſtruments in common Uſe, that are immediately derived from the Mechanical Organs.

LECTURE IV.

A Compound Engine, in which are applied all the Simple Machines.
Of Friction and Experiments thereon.
How to compute the Friction on any Axis.
The good and bad Qualities of Wheel-Carriages explain'd.
Experiments to ſhew the Advantages of great and ſmall Wheels according to the different Circumſtances in Coaches, Carts, &c.
Experiments on Friction Wheels.
The Advantantages of Wheel-Carriages, when improv'd by Friction Wheels.
How to compute the Friction of Ropes, running over Rollers and Pulleys.
Of the Strength of Men and Horſes.
Of the Deſcent of Bodies.
Experiments to determine the Force of deſcending Bodies.
That Bodies will aſcend to the ſame Height from whence they fall, by the Force which they acquire in falling, when all Obſtacles are remov'd.
That the Velocities of deſcending Bodies, are as the Times of Deſcent.
That the Spaces run thro' by deſcending Bodies, are as the Squares of the Times of Deſcent.

LECTURE V.

OF the Motion of Projectiles.

How a Body will move, when it's projectile Force either yields to, or overcomes, or exactly ballances that of Gravity.

Of the Aſcent and Deſcent of heavy Bodies upon any Surface, inclin'd to the Plane of the Horizon.

Of the Theory of Pendulums.

Experiments concerning Pendulums.

Of the Centers of Oſcillation and Percuſſion.

Of the Cycloid, and of Bodies moving in that Curve.

The Length, and conſequently the Motion of Pendulums, alter'd by Heat and Cold.

The Pyrometer, being a curious Machine for ſhewing the Expanſion of Metals, or any other Bodies by Heat.

Of Centripetal and Centrifugal Forces.

Many of the curious Propoſitions of Sir *Iſaac Newton*, on Central Forces, proved by Experiments; particularly that famous Propoſition, that the Planets revolve round the Sun in ſuch a Manner, as that the Squares of the Periodic Times are as the Cubes of the Diſtances.

LIBRARY.

HYDROSTATICS.

LECTURE VI.

CONcerning Fluids and Fluidity in general.
Of the Incompreſſibility of Water.
Of the Equilibrium of Fluids.
Of what Uſe it is to conſider Fluids divided into Parts, by imaginary Surfaces, or by perpendicular Columns.
That Fluids preſs in all manner of Directions at the ſame Time.
That Fluids of different kinds gravitate on each other.
How the heavieſt Bodies may be made to ſwim in Water; and light ones depreſs'd therein.
The Hydroſtatical Paradox explain'd.
Experiment, ſhewing that a Pint of Water may be made to preſs with as much Force as ſeveral Gallons; and that a Man may raiſe a very great Weight by the Force of his Lungs.

LECTURE VII.

OF Syphons, their Nature and manner of Working, explain'd by ſeveral Experiments.
The Flowing and Ebbing of Inland Ponds accounted for.
The famous Propoſition of *Archimedes*, concerning King *Hiero*'s Crown explain'd.
Of the Hydroſtatical Ballance.
How to find the Specific Gravity of any Body.

Experiments

Experiments concerning the Specific Gravity of Gold, Silver and other Bodies; and to ſhew that ſuch Bodies weigh'd in Water, looſe juſt ſo much of their Weight, as is equal to the Weight of the Fluid diſplaced by the Body.

LECTURE VIII.

OF Fountains and Spouting-Water.

Experiments to ſhew to what Height, and why Water will riſe in Fountains and oblique Jets.

How to find, to what Horizontal Diſtance Water will ſpout from the Side of an upright Veſſel or Reſervoir.

The Quantity of Water, ſpouting from equal Holes at any given Depth below the Surface computed, and ſhewn to be as the Square Roots of thoſe Depths.

Several Articles relating to the making of Jets, and the Conveyance of Water thro' Pipes conſider'd and computed.

The Preſſure of Water on Banks, Gates, and Sluices computed.

The Theory and Practice of Pumps explain'd by curious Models in Glaſs.

A Model of an Engine for extinguiſhing of Fires ſhewn and explain'd.

Of

Of PNEUMATICS.

LECTURE IX.

OF the Nature of Air in general.
Of ſuch Properties of Air, as are common to other Fluids.
Of the Properties peculiar to Air.
Of the Rarefaction and Condenſation of Air by Heat and Cold.
To determine the Specific Gravity of Air, relative to Water.
Experiments to prove the Elaſticity and Preſſure of Air.
That the Denſity and Spring of the Air, is exactly proportional to the compreſſing Force.
That the Preſſure of Air decreaſes according to the Diſtance from the Surface of the Earth.
Syringes and Cupping-Glaſſes deſcrib'd.
Artificial Lungs.
Of the Barometer and its Conſtruction; and alſo, of the riſing and falling of the Quickſilver therein, accounted for.
Of the Thermometer and its Conſtruction.

LECTURE X.

OF the Air-Pump, and its manner of working explain'd.
The Weight or Preſſure and Spring of the Air directly prov'd by many Experiments, ſome of which are;
By breaking of Glaſs-Phials.
By the Senſe of Feeling.
By ſome Phænomena of Bladders, Glaſs-Bubbles, &c.

Quick-

Quickſilver rais'd to the uſual Height in the Barometer, by the bare Spring of a little inclos'd Air.

Barometers and Fountains *in Vacuo*.

Of the Ebulition of Liquors *in Vacuo*.

The famous Experiment of *Otto Guerrick*'s Hemiſpheres.

Experiments made with a condenſing Engine.

An Experiment, ſhewing that Denſe Air, acts on common Air, as common Air does on a Vacuum.

That Fire and Flame are fed by Air.

The Effects of condenſed and burnt Air on the Lives of Animals.

LECTURE XI.

OF Sound, and the manner of its Propagation.

An Experiment ſhewing that Air is the Vehicle by which Sound is convey'd.

That Sound is encreas'd or diminiſh'd, according as the Air is rarified or condens'd, prov'd by Experiment.

The Diving-Bell, with all Dr. *Halley*'s, and Mr. *Triewald*'s Improvements.

The riſing and falling of Glaſs Bubbles and Images accounted for.

How to find what Weight of Air preſſes on our Bodies at any Time: And alſo the Weight of Air on the whole Earth.

Of Winds in general.

Dr. *Halley*'s Hiſtorical Account of the Trade Winds and Monſoons; with an Attempt towards explaining their Phyſical Cauſes.

Of Vapours, Clouds and Rain.

Of the Force of rarified Vapours in raiſing Water by Fire.

The Explanation of an Engine for raiſing Water by Fire.

OPTICS.

PATENT OFFICE

OPTICS.

LECTURE XII.

OF Heat, Fire and Flame.
Sir *Iſaac Newton*'s Account thereof.
Of Viſion in general.
Concerning the Nature and Motion of Light.
Of Dioptrics, the Laws on which it is founded explain'd by Experiments.
Experiments ſhewing the Ratio of the Sines of the Angles of Incidence and Refraction, in different Mediums.
Experiments to ſhew the Nature of Convex and Concave Glaſſes, or Lenſes, and the manner of the Rays of Light paſſing thro' them and uniting in their Focus's.
How to find the Focus of any Lens.
Of Catoptrics; the Law on which it is founded prov'd by Experiment.
Of Plane Mirrours and the Plane of Inflection.
Of the ſeveral Images caus'd by two Looking-Glaſſes.
Of Convex, Concave, and Cylindrical Mirrours.
How to find the Focus and magnifying Power of a Spherical Mirrour.
Of the Power of Burning by Optic Glaſſes and Speculums.

LECTURE

LECTURE XIII.

OF the Eye, its Coats and Humours explain'd.
The Nature of Viſion ſhewn by an Artificial Eye.
The Diſection of a real Eye, and the Faults of Viſion ſhewn.
Experiments to ſhew how Defects in Eyes may be helped.
Of the Magnitude and Degree of Brightneſs of Objects.
Of the Proportion of Day-light to Moon-light.
Of the Limits of diſtinct Viſion.
Of the magnifying Power of a ſingle Lens.
The Conſtruction of the Camera Obſcura and Magic Lanthorn.

LECTURE XIV.

OF the Combinations of Optic Glaſſes.
The manner of conſtructing the different Sorts of refracting Teleſcopes.
Of the double Microſcope, and the manner of uſing it explain'd.
Of the Nature and Conſtruction of reflecting Teleſcopes.
Of the Colours of which the Particles of Light are compoſed.
The Colours of Natural Bodies.
Experiments to ſhew, that the Colours of natural Bodies depend on the Texture of their component Parts.
An Explanation of the Phænomenon of the Rainbow.
How Dioptrical Inſtruments are affected by the different Refrangibility of the Rays of Light.

CONTENT OF THE LIBRARY.

ASTRONOMY.

LECTURE XV.

OF the Syſtem of the World, the Order and Periods of the Primary Planets about the Sun, and of the Secondary Planets round their Primary Ones.
Concerning the Diſtance of the fixed Stars.
Precautions concerning apparent Motion and Place.
The Annual and Diurnal Motion of the Earth, and the Phænomena thence ariſing.
Of the Phænomena of the Inferior and Superior Planets.

LECTURE XVI.

OF the Motions of the Moon, and the Nature of Eclipſes explain'd.
Of the Satellites of Jupiter and Saturn; and of Saturn's Ring.
Of the Geographical Latitude and Longitude of Places.
Of the Crepuſculum or Twylight.
Of the Refraction of the Stars.
Of the Figure of the Planets.
The Preceſſion of the Equinoctial Points accounted for.
The real Motion of the Sun explain'd.
The ſeveral Methods made Uſe of to meaſure the Diameter of the Earth.
Of the Parallaxes and abſolute Diſtances of the Heavenly Bodies.
Of Comets.
Of Tides.

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